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SILVER AND ANTIMONY CONTENTS OF GALENA FROM THE BRUNSWICK NO. 12 MINE

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by

J.H.G. Laflamme & L.J. Cabri

SUMMARY

The median silver and antimony contents of galena from the mill circuit (1985) of Brunswick Mining and Smelting Corporation Limited (N.P.L.) were determined to be 0.074 and 0.103 wt. % Ag and Sb respectively, with 94% of the analyses >0.02 and <0.13 wt. % Ag. These results, calculated on the basis of analyses previously reported in MSL 86-91(IR) as well as new analyses, confirm a lower silver content (solid solution) of galena by about 10% than that reported by Owens (1980) for galena representative of ore mined in 1977.

TENEURS EN ARGENT ET EN ANTIMOINE DE LA GALENE PROVENANT DE LA MINE BRUNSWICK NO. 12

par

J.H.G. Laflamme & L.J. Cabri

RESUME

Les teneurs médianes en argent et en antimoine de la galène provenant du circuit de traitement (1985) de la Brunswick Mining and Smelting Corporation Limited (N.P.L.) ont été déterminées à 0,074 et 0,103% en poids respectivement pour l'argent et l'antimoine, et la teneur en argent de 94% des analyses tombe entre 0,02 et 0,13% en poids. Ces résultats qui sont calculés à partir des analyses rapportées dans MSL 86-91(IR) de même qu'avec une nouvelle série d'analyses confirment à la baisse la teneur en argent (en solution solide) de la galène par environ 10% de moins que la teneur en argent déterminée par Owens (1980) pour la galène contenue dans le minerai exploité en 1977.

INTRODUCTION

This study is part of mineralogical research in CANMET project on the Silver Recovery in the Zinc Industry which deals with quantification of the contribution of major minerals to the distribution of trace elements. As stated by Laflamme and Cabri (1986), two hundred and forty galena grains from Brunswick Mining and Smelting Corporation Limited (N.P.L.) were analysed for silver with an electron microprobe by Owens (1980) from samples that came from ore mined in 1977. It was subsequently considered essential to analyse a new series of samples to determine possible variations in silver content of galena between currently mined ore and that mined in 1977. Additionally, analyses with a new "state of the art" electron microprobe were expected to have an analytical limit of detection lower than the 350 ppm reported by Owens (1980). After study of the series of analyses for Ag and Bi in galena, reported in Laflamme and Cabri (1986), it was deemed useful to determine the Sb concentration as well. Silver was also re-analysed to provide additional data on the Ag distribution.

SAMPLES

The same polished section used in the study on the distribution of Ag and Bi in galena from Brunswick No. 12 mine (Laflamme and Cabri 1986) was used in the present study. This polished section was prepared from a portion of a table concentrate prepared from a 1-kg split of a 2-kg secondary cyclone underflow ore sample received from L.J. Surges of Brunswick Mining and Smelting Corp. Ltd., near the end of September 1985. Microscopic examination of the table concentrate revealed that it consists mainly of galena with minor amounts of pyrite and sphalerite, with traces

of arsenopyrite and chalcopyrite. As observed and reported by Laflamme and Cabri (1986), the presence of boulangerite and diaphorite was also noticed during this investigation, together with silver-bearing tetrahedrite.

ANALYTICAL PROCEDURES

The analyses were done by wavelength dispersive spectrometry using a JEOL-733 superprobe operated at 20 kV and a cup current of 40 nanoamperes with 100-second counting periods. The following X-ray lines and standards were used for galena analyses: AgLα using synthetic (Pb,Ag)S with 0.40 wt. % Ag, SbLα and BiMα using pure metals. A synthetic PbS standard was used for accurate background measurements. The minimum detection levels (MDL) were found to be 0.02 wt. % for Ag and Sb, and 0.07 wt. % for Bi. Extreme care was taken to avoid erroneous results due to fine-grained inclusions of silver or antimony minerals as each area was carefully examined with the backscattered electron detector at high magnification prior to analysis. Quantitative corrections were applied to raw data by using the ZAF factors generated from Tracor Northern's ZAF program (Version 12).

RESULTS

A total of 116 grains selected at random and measuring at least 50 micrometres in width were quantitatively analysed for Ag and Sb, for a total of 350 spot analyses. The results are tabulated in Table 1. Additionally, some of the grains which gave high Ag values were also analysed for Bi because high Ag-bearing grains are generally Bi-rich, as reported by Laflamme and Cabri (1986). These results are tabulated in Table 2.

DISCUSSION

Silver

Silver was detected with values greater than the MDL of 0.02 wt. % in all but two of 350 spot analyses, compared to about 90% of the analyses reported by Owens (1980) with a MDL of 0.035 wt. %. The median value for all 350 analyses is 0.073 wt. % Ag, which is almost identical to the median value of 0.075 wt. % obtained in the first series of analyses, reported by Laflamme and Cabri (1986). Combination of the results obtained in the present study with those previously reported in Laflamme and Cabri (1986), gives a median value for all 700 analyses of 0.074 wt. % Ag with 94% of the analyses >0.02 and <0.13 wt. % Ag (Fig. 1A). Once again, the distribution of the analyses on two frequency plots (Fig. 1A & 1B) suggests one population, and furthermore, the frequency distribution and the minimal variation within each grain suggests that the median value for all 700 analyses may be simply used as a representative value of the silver content in solid solution in galena for the sample analysed. The arithmetic mean of all 700 spot analyses is 0.0775 wt. % Ag, which is very close to the median value.

As observed previously in the first series of galena analyses, high silver values are usually accompanied by high bismuth values. This is demonstrated in Table 2 for four different grains for which the highest value of 0.599 wt. % Bi was observed.

Antimony

The Sb content varied from less than the MDL (0.02 wt. %) to a high value of 0.206 wt. % Sb, with 98% of the 350 spots analysed having values

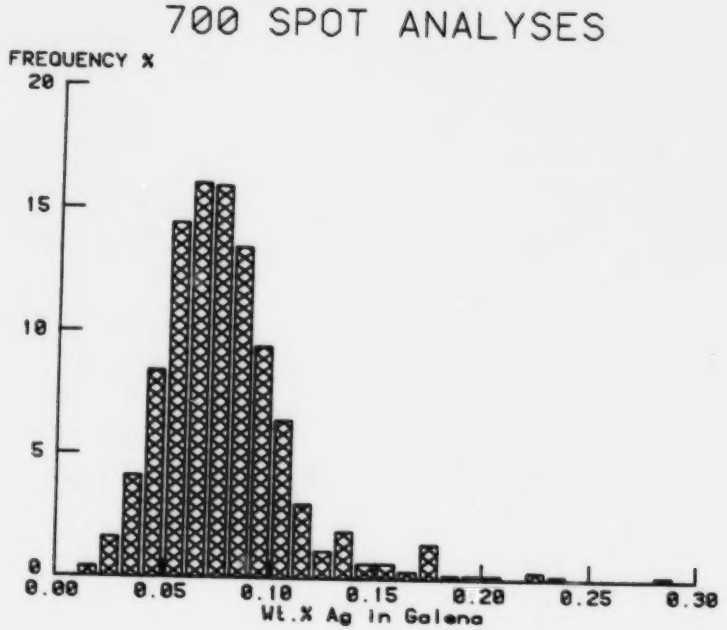

Figure 1A. Frequency distribution of silver in galena for 700 spot analyses.

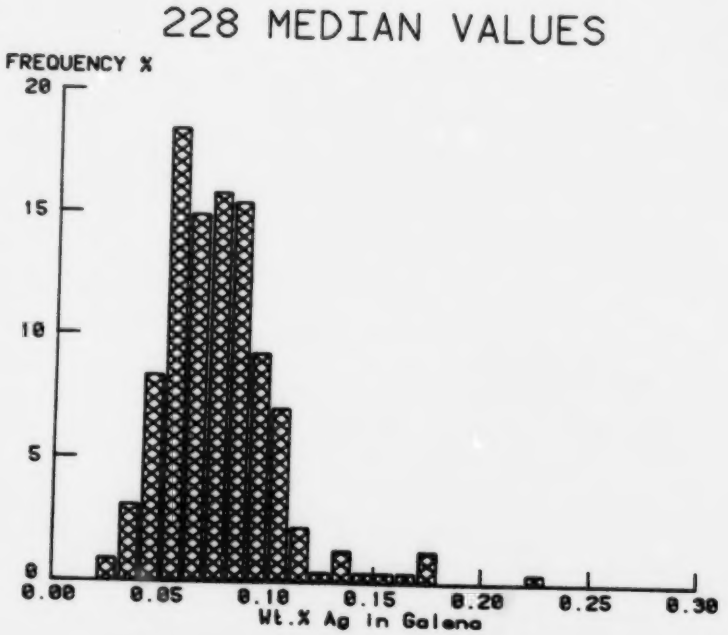

Figure 1B. Frequency distribution of silver in galena for 228 median values.

greater than the MDL (Fig. 2A & 2B). The median value for all 350 spots is 0.103 wt. % Sb, which is essentially identical to an arithmetic mean of 0.101 wt. %, obtained by assuming "0" for analyses (seven) lower than the detection limit.

CONCLUSIONS

The large number of spot analyses (700) are conclusive in providing a true value for Ag in solid solution in galena representative of ore mined in 1985 from the Brunswick No. 12 mine. The median Ag value of 0.074 wt. % clearly indicates a single galena population with a slight bias of values >0.13 wt. %.

In a similar manner, the Sb and the Bi results currently and previously reported, respectively, give realistic estimates of the Sb and Bi contents of galena. The Sb content of 0.103 wt. % in particular, should provide some of the data base required to determine the Ag contribution by tetrahedrite in metal balance calculations.

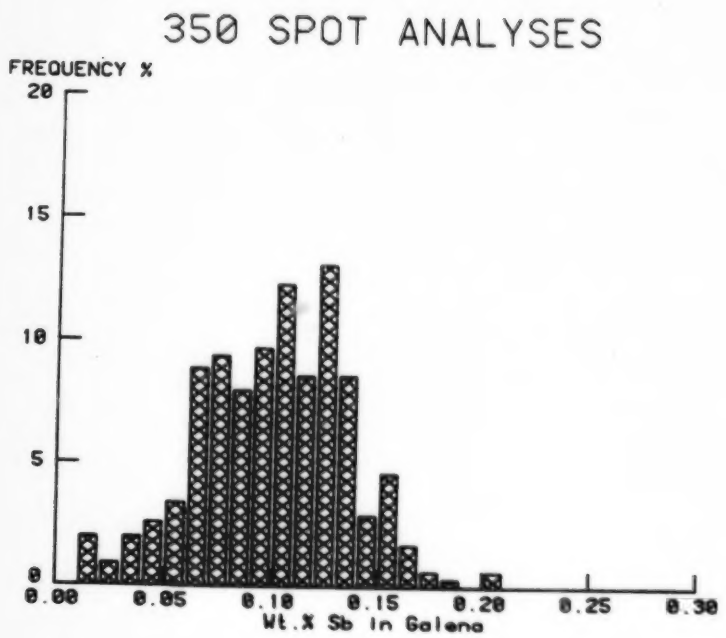

Figure 2A. Frequency distribution of antimony in galena for 350 spot analyses.

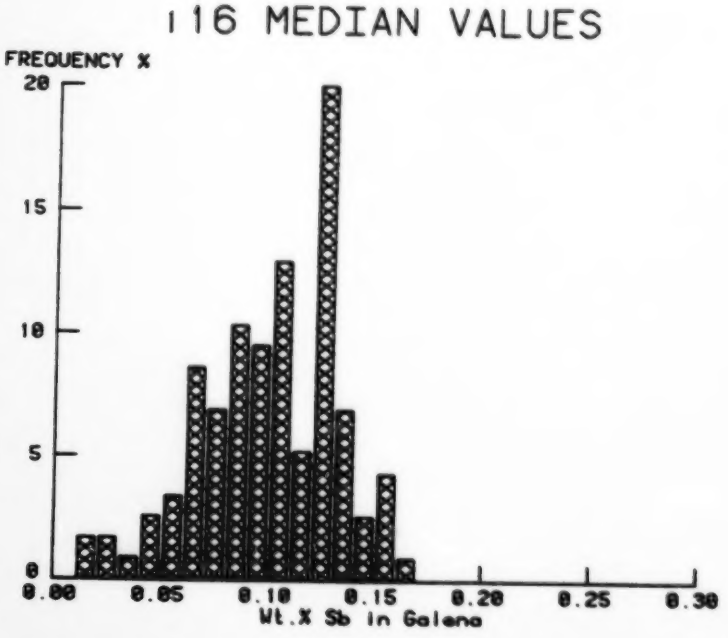

Figure 2B. Frequency distribution of antimony in galena for 116 median values

ACKNOWLEDGEMENTS

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REFERENCES

Owens, D.R., Silver distribution in mill products from Brunswick Mining and Smelting Corporation Limited, Bathurst, New Brunswick; Mineral Sciences Laboratories, Division Report MRP/MSL 80-83 (IR); CANMET, Energy, Mines & Resources Canada; p. 23, 1980.

Laflamme, J.H.G. and Cabri, L.J., Silver and bismuth contents of galena from the Brunswick No. 12 Mine; Mineral Sciences Laboratories, Division Report MSL 86-91 (IR); CANMET, Energy, Mines & Resources Canada; 1986.

Table 1. Ag and Sb Contents of Galena from a Secondary Cyclone Underflow Ore Sample (BMS)

	wt. % Ag	Median Value	wt. % Sb	Median Value		wt.% Ag	Median Value	wt. % Sb	Media Value
Grain 1	0.057		0.135		Grain 12	<MDL		0.063	
	0.037	0.057	0.098	0.123		0.038	0.025	0.079	0.071
	0.078		0.123			0.025		0.071	
Grain 2	0.067		0.124		Grain 13	0.070		0.100	
	0.071	0.068	0.160	0.160		0.068	0.068	0.087	0.087
	0.068		0.204			0.061		0.087	
Grain 3	0.082		0.107		Grain 14	0.082		0.122	
	0.094	0.083	0.112	0.107		0.095	0.084	0.130	0.122
	0.083		0.104			0.084		0.111	
Grain 4	0.054		0.062		Grain 15	0.049		0.103	
	0.074	0.054	0.076	0.067		0.065	0.065	0.105	0.105
	0.032		0.067			0.087		0.105	
Grain 5	0.087		0.127		Grain 16	0.045		0.078	
	0.055	0.070	0.099	0.099		0.063	0.048	0.102	0.078
	0.070		0.097			0.048		0.073	
Grain 6	0.110		0.163		Grain 17	0.057		0.076	
	0.093	0.093	0.133	0.133		0.060	0.057	0.068	0.068
	0.053		0.084			0.055		0.056	
Grain 7	0.088		0.123		Grain 18	0.080		0.136	
	0.098	0.088	0.137	0.123		0.120	0.080	0.155	0.136
	0.072		0.080			0.073		0.136	
Grain 8	0.060		0.138		Grain 19	0.064		0.124	
	0.064	0.060	0.122	0.122		0.059	0.064	0.140	0.134
	0.052		0.097			0.076		0.134	
Grain 9	0.059		0.093		Grain 20	0.065		0.137	
	0.060	0.060	0.095	0.095		0.063	0.064	0.169	0.153
	0.068		0.113			0.064		0.153	
Grain 10	0.064		0.093		Grain 21	0.179		0.090	
	0.064	0.064	0.095	0.095		0.178		0.068	
	0.090		0.144			0.175	0.179	0.082	0.082
Grain 11	0.062		0.106			0.200		0.074	
	0.075	0.075	0.138	0.109		0.207		0.114	
	0.076		0.109						

	wt. % Ag	Median Value	wt. % Sb	Median Value		wt.% Ag	Median Value	wt. % Sb	Media Value
Grain 22	0.078		0.136		Grain 34	0.083		0.104	
	0.101	0.078	0.134	0.134		0.065	0.083	0.072	0.096
	0.078		0.119			0.084		0.096	
Grain 23	0.068		0.082		Grain 35	0.175		0.028	
	0.079	0.077	0.066	0.082		0.152	0.155	0.039	0.028
	0.077		0.083			0.155		<MDL	
Grain 24	0.058		0.103		Grain 36	0.037		0.061	
	0.071	0.058	0.107	0.105		0.025	0.032	0.059	0.059
	0.058		0.105			0.032		0.056	
Grain 25	0.089		0.114		Grain 37	0.088		0.119	
	0.105	0.089	0.124	0.124		0.066	0.083	0.102	0.110
	0.086		0.151			0.083		0.110	
Grain 26	0.125		<MDL		Grain 38	0.101		0.162	
	0.119	0.122	0.022	0.022		0.082	0.092	0.137	0.137
	0.122		0.034			0.092		0.118	
Grain 27	0.066		0.115		Grain 39	0.075		0.117	
	0.090	0.066	0.124	0.124		0.070	0.070	0.128	0.128
	0.061		0.137			0.063		0.139	
Grain 28	0.058		0.051		Grain 40	0.069		0.100	
	0.066	0.058	0.078	0.067		0.070	0.069	0.089	0.089
	0.056		0.067			0.066		0.078	
Grain 29	0.065		0.091		Grain 41	0.086		0.119	
	0.080	0.065	0.120	0.104		0.095	0.095	0.107	0.119
	0.057		0.104			0.098		0.123	
Grain 30	0.044		0.109		Grain 42	0.055		0.095	
	0.066	0.066	0.129	0.129		0.073	0.056	0.130	0.127
	0.078		0.145			0.056		0.127	
Grain 31	0.086		0.125		Grain 43	0.223		0.057	
	0.086	0.086	0.131	0.125		0.222	0.223	0.047	0.057
	0.076		0.105			0.239		0.069	
Grain 32	0.059		0.075		Grain 44	0.033		0.075	
	0.078	0.076	0.062	0.067		0.045	0.033	0.102	0.076
	0.076		0.067			0.032		0.076	
Grain 33	0.027		0.054		Grain 45	0.091		0.129	
	0.037	0.037	0.044	0.054		0.098	0.096	0.170	0.130
	0.048		0.061			0.096		0.130	

	wt. % Ag	Median Value	wt. % Sb	Median Value		wt.% Ag	Median Value	wt. % Sb	Media Value
Grain 46	0.138 0.140 0.135	0.138	0.095 0.078 0.090	0.090	Grain 58	0.053 0.049 0.062	0.053	0.062 0.069 0.068	0.068
Grain 47	0.070 0.091 0.079	0.079	0.115 0.154 0.151	0.151	Grain 59	0.085 0.063 0.064	0.064	0.091 0.110 0.097	0.097
Grain 48	0.098 0.084 0.077	0.084	0.124 0.129 0.152	0.129	Grain 60	0.106 0.107 0.100	0.106	0.101 0.111 0.078	0.101
Grain 49	0.060 0.090 0.064	0.064	0.125 0.153 0.101	0.125	Grain 61	0.041 0.033 0.048	0.041	0.071 0.072 0.085	0.072
Grain 50	0.049 0.059 0.062	0.059	0.149 0.126 0.158	0.149	Grain 62	0.118 0.087 0.116	0.116	0.084 0.073 0.099	0.084
Grain 51	0.058 0.054 0.057	0.057	0.089 0.066 0.089	0.089	Grain 63	0.087 0.113 0.079	0.087	0.117 0.135 0.106	0.117
Grain 52	0.051 0.058 0.063	0.058	0.100 0.095 0.107	0.100	Grain 64	0.044 <MDL 0.043	0.043	0.051 0.054 0.068	0.054
Grain 53	0.085 0.102 0.065	0.085	0.135 0.156 0.132	0.135	Grain 65	0.083 0.081 0.095	0.083	0.134 0.113 0.128	0.128
Grain 54	0.097 0.079 0.081	0.081	0.099 0.102 0.104	0.102	Grain 66	0.103 0.107 0.101	0.103	<MDL 0.031 <MDL	<MDL
Grain 55	0.063 0.076 0.060	0.063	0.153 0.146 0.156	0.153	Grain 67	0.084 0.080 0.101	0.084	0.137 0.105 0.113	0.113
Grain 56	0.075 0.057 0.049	0.057	0.095 0.086 0.061	0.086	Grain 68	0.078 0.108 0.105	0.105	0.110 0.123 0.140	0.123
Grain 57	0.064 0.039 0.040	0.040	0.072 0.055 0.066	0.066	Grain 69	0.046 0.066 0.051	0.051	0.076 0.096 0.080	0.080

	wt. % Ag	Median Value	wt. % Sb	Median Value		wt.% Ag	Median Value	wt. % Sb	Median Value
Grain 70	0.073		0.121		Grain 82	0.087		0.106	
	0.100	0.092	0.183	0.133		0.092	0.087	0.110	0.106
	0.092		0.133			0.087		0.100	
Grain 71	0.106		0.158		Grain 83	0.097		0.131	
	0.073	0.073	0.098	0.106		0.088	0.088	0.127	0.127
	0.057		0.106			0.080		0.120	
Grain 72	0.036		0.068		Grain 84	0.140		0.084	
	0.052	0.043	0.113	0.109		0.136	0.136	0.091	0.091
	0.043		0.109			0.136		0.102	
Grain 73	0.091		0.044		Grain 85	0.076		0.122	
	0.083	0.091	0.039	0.044		0.064	0.064	0.130	0.122
	0.094		0.048			0.061		0.085	
Grain 74	0.090		0.137		Grain 86	0.053		0.070	
	0.096	0.092	0.128	0.130		0.045	0.047	0.077	0.070
	0.092		0.130			0.047		0.065	
Grain 75	0.074		0.130		Grain 87	0.097		0.132	
	0.061	0.072	0.171	0.171		0.120	0.105	0.162	0.146
	0.072		0.206			0.105		0.146	
Grain 76	0.063		0.100		Grain 88	0.064		0.072	
	0.071	0.063	0.105	0.100		0.044	0.059	0.070	0.070
	0.056		0.085			0.059		0.068	
Grain 77	0.069		0.144		Grain 89	0.104		0.074	
	0.055	0.061	0.118	0.129		0.087	0.088	0.072	0.072
	0.061		0.129			0.088		0.058	
Grain 78	0.173		0.047		Grain 90	0.081		0.128	
	0.176	0.176	0.048	0.047		0.034	0.046	0.070	0.070
	0.190		0.038			0.046		0.051	
Grain 79	0.058		0.083		Grain 91	0.048		0.155	
	0.053	0.053	0.089	0.084		0.072	0.072	0.145	0.145
	0.047		0.084			0.072		0.145	
Grain 80	0.096		0.102		Grain 92	0.067		0.149	
	0.088	0.088	0.124	0.114		0.078	0.068	0.126	0.126
	0.072		0.114			0.068		0.091	
Grain 81	0.066		0.121		Grain 93	0.093		0.126	
	0.073	0.072	0.126	0.121		0.083	0.093	0.116	0.126
	0.072		0.108			0.128		0.178	

	wt. % Ag	Median Value	wt. % Sb	Median Value		wt.% Ag	Median Value	wt. % Sb	Media Value
Grain 94	0.127 0.110 0.108	0.110	<MDL <MDL <MDL	<MDL	Grain 106	0.079 0.071 0.052	0.071	0.094 0.091 0.090	0.091
Grain 95	0.119 0.061 0.108	0.108	0.110 0.058 0.111	0.110	Grain 107	0.098 0.091 0.067	0.091	0.128 0.129 0.110	0.128
Grain 96	0.093 0.115 0.086	0.093	0.092 0.097 0.080	0.092	Grain 108	0.117 0.122 0.114	0.117	0.089 0.069 0.100	0.089
Grain 97	0.066 0.085 0.079	0.079	0.075 0.119 0.097	0.097	Grain 109	0.081 0.058 0.075	0.075	0.102 0.077 0.124	0.102
Grain 98	0.114 0.090 0.113	0.113	0.090 0.061 0.078	0.078	Grain 110	0.049 0.045 0.038	0.045	0.121 0.103 0.083	0.103
Grain 99	0.054 0.042 0.039	0.042	0.073 0.112 0.088	0.088	Grain 111	0.114 0.066 0.050	0.066	0.112 0.088 0.089	0.089
Grain 100	0.101 0.090 0.069	0.090	0.156 0.134 0.125	0.134	Grain 112	0.053 0.062 0.048	0.053	0.072 0.080 0.066	0.072
Grain 101	0.075 0.101 0.072	0.075	0.116 0.136 0.124	0.124	Grain 113	0.033 0.031 0.028	0.031	0.022 0.042 0.031	0.031
Grain 102	0.071 0.075 0.096	0.075	0.125 0.106 0.142	0.125	Grain 114	0.076 0.088 0.076	0.076	0.120 0.140 0.118	0.120
Grain 103	0.054 0.058 0.032	0.054	0.062 0.067 0.064	0.064	Grain 115	0.104 0.047 0.086	0.086	0.163 0.100 0.152	0.152
Grain 104	0.062 0.037 0.081	0.062	0.108 0.084 0.135	0.108	Grain 116	0.052 0.048 0.054	0.052	0.117 0.124 0.108	0.117
Grain 105	0.051 0.061 0.044	0.051	0.047 0.044 0.031	0.044					

Total of 350 spot analyses performed on 116 grains selected at random.
Arithmetic mean for Ag content, 0.078 wt. % (<MDL to 0.239 wt. %); median value of 0.073 wt. %.
Arithmetic mean for Sb content, 0.101 wt. % (<MDL to 0.206 wt. %); median value of 0.103 wt. %.
In the calculation of the arithmetic means, <MDL values were taken as 0.

Table 2. Bi Contents of some Hi-Ag Galena Grains from a Secondary Cyclone Underflow Ore Sample (BMS).

	wt. % Bi	Median Value	Ag Content
Grain 21	0.288		
	0.327		
		0.323	(0.179 Ag)
	0.320		
	0.377		
Grain 35	0.457		
	0.464	0.464	(0.155 Ag)
	0.465		
Grain 43	0.548		
	0.599	0.569	(0.223 Ag)
	0.569		
Grain 46	0.240		
	0.228	0.228	(0.138 Ag)
	0.140		